Appendix B. Soil Classification Guide (Cohesive Soil)

COHESIVE SOILS (Modified after Ref. D2487-93 and D2488-93)

Table 1: Fine Grained Soil Subclassification	Percent (by weight) of Total Sample
Terms **SILT, LEAN CLAY, FAT CLAY, ELASTIC SILT** **Sandy, gravelly, abundant cobbles, abundant boulders** **with sand, with gravel, with cobbles, with boulders** **scattered sand, scattered gravel, scattered cobbles, scattered boulders** **a trace sand, a trace gravel, a few cobbles, a few boulders**	*** PRIMARY CONSTITUENT** **>30 - 50]** **>15 - 30] - Secondary coarse grained constituents** **5 - 15]** **<5]**
*** The relationship of clay and silt constituents is based on plasticity and normally determined by performing index tests. Refined classifications are based on Atterberg Limits tests and the Plasticity Chart.**	

Modified after Ref. Oregon DOT 1987, DM 7.1 1982, and FHWA 1997)

TERM	NUMBER OF BLOWS PER 1 FT.	POCKET PENETROMETER (tsf)	FIELD TEST
Very Soft	0 - 1	0.25 or Less	Squeezes between fingers when fist is closed, penetrated several inches by fist.
Soft	2 - 4	0.25 - 0.50	Easily molded by fingers, easily penetrated several inches by thumb.
Medium Stiff	5 - 8	0.50 - 1.00	Molded by strong pressure of fingers, can be penetrated several inches by thumb with moderate effort.
Stiff	9 - 15	1.00 - 2.00	Dented by strong pressure of fingers, readily indented by thumb but can be penetrated only with great effort.
Very Stiff	16 - 30	2.00 - 4.00	Readily indented by thumb nail.
Hard	31 - 60	over 4.00	Indented with difficulty by thumb nail.
Very Hard	61 -		

MOISTURE CONDITION (Modified after Ref. D2488-93)

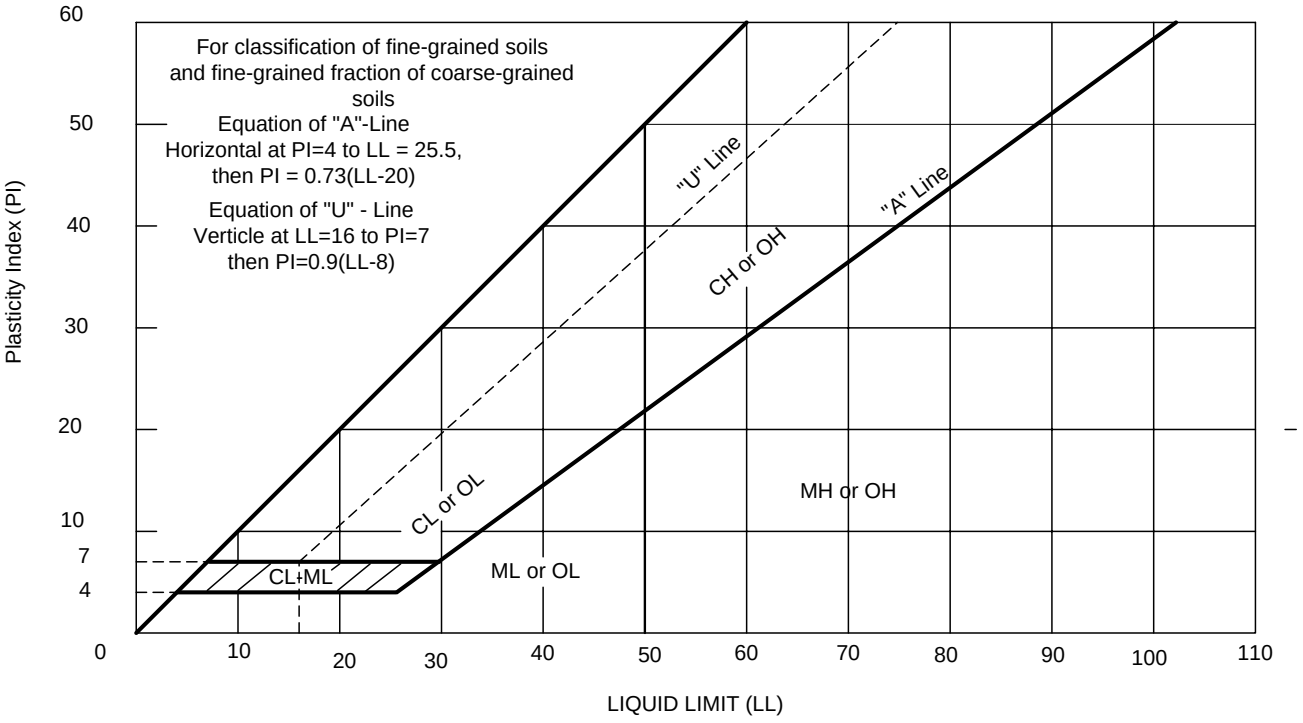
DESCRIPTIVE TERM	GUIDE
Dry	No indication of water
Moist	Indication of water
Wet	Visible water

CRITERIA FOR DESCRIBING STRUCTURE (Modified after Ref. D2488-93)

Description	Criteria
Stratified	Alternating layers of varying material or color with layers at least 1/4 inch (6mm) thick; note thickness
Laminated	Alternating layers of varying material or color with the layers less than 6mm thick; note thickness
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
Homogeneous	Same color and appearance throughout
Layer	Inclusion greater than 3 inches thick (7.5 cm)
Seam	Inclusion 1/8 inch to 3 inches (3 to75 mm) thick extending through the sample
Parting	Inclusion less than 1/8 (3 mm) inch thick

Appendix B.1 Plasticity Chart

ASTM D 2487



Appendix C. Soil Classification guide (Non Cohesive)

NON-COHESIVE (GRANULAR) SOILS (Modified after Ref. D2487-93 and D2488-93)

Table 2: Coarse Grained Soil Subclassification	Percent (by weight) of Total Sample
Terms	
GRAVEL, SAND, COBBLES, BOULDERS	**PRIMARY CONSTITUENT**
sandy, gravelly, abundant cobbles, abundant boulders	**>30 - 50]**
with gravel, with sand, with cobbles, with boulders	**>15 - 30] - Secondary coarse grained constituents**
scattered gravel, scattered sand, scattered cobbles, scattered boulders	**5 - 15]**
a trace gravel, a trace sand, a few cobbles, a few boulders	**<5]**
Silty (MH & ML)*, clayey (CL & CH)*	**> 15]**
(with silt, with clay)*	**5 - 15] - Secondary fine grained constituents**
(trace silt, trace clay)*	**<5]**
*** Index tests and/or plasticity tests are performed to determine whether the term "silt" or "clay" is used.**	

GRAIN SIZE IDENTIFICATION (Modified after Ref. Oregon DOT 1987 and FHWA 1997)

NAME	SIZE LIMITS	FAMILIAR EXAMPLE
Boulder	**12in. (305mm) or more**	**Larger than basketball**
Cobbles	**3in. (76mm) -12in. (305mm)**	**Grapefruit**
Coarse Gravel	**3/4in. (19mm) - 3in. (76mm)**	**Orange or Lemon**
Fine Gravel	**4.75mm (No. 4 sieve) - 3/4in. (19mm)**	**Grape or Pea**
Coarse Sand	**2mm (No. 10 sieve) - 4.75mm (No. 4 sieve)**	**Rocksalt**
Medium Sand	**0.42mm (No. 40 sieve) - 2mm (No. 10 sieve)**	**Sugar, Table Salt**
Fine Sand*	**0.075mm (No. 200 sieve) - 0.42mm (No. 40 sieve)**	**Powdered Sugar**
Fines	**Less than 0.075mm (No. 200 sieve)**	
*** Particles finer than fine sand cannot be discerned with the naked eye at a distance of 8in. (20cm).**		

(Modified after Ref. FHWA 1997)

MOISTURE CONDITION		DENSITY	
DESCRIPTIVE TERM	**GUIDE**	**TERM**	**N-VALUE (bpf)**
Dry	**No indication of water**	**Very Loose**	**00 - 04**
Moist	**Damp but no visible water**	**Loose**	**05 - 10**
Wet	**Visible free water, usually soil is below water table**	**Medium Dense**	**11 - 24**
		Dense	**25 - 50**
		Very Dense	**over 51**

Appendix D. Rock Classification Guide

MECHANICAL SEDIMENTARY ROCK (Modified after Ref. DM 7.1 1982 and Oregon DOT 1987)			
GRAIN SIZE	**COMPOSITION**		**NAME**
Mostly coarse grains	Rounded pebbles in medium grained matrix.		Conglomerate
	Angular coarse rock fragments.		Breccia
More than 50% of medium grains	Medium quartz grains	Less than 10% of other minerals	Sandstone
	Medium quartz grains	Appreciable quantity of clay minerals	Argillaceous sandstone
		Appreciable quantity of calcite	Calcareous sandstone
		Over 25% feldspar	Arkose
More than 50% fine grain size	Fine to very fine quartz grains with clay minerals, gritty feel		Siltstone (if laminated silt shale)
More than 50% fine grain size	Microscopic clay minerals and very fine quartz <10% other minerals		Mudstone or claystone (if laminated clay shale)
CHEMICAL SEDIMENTARY ROCKS			
GRAIN SIZE	**COMPOSITION**		**NAME**
Microscopic	Calcite fragments and calcite cement. White or gray or bluish in color. Fizzes strongly with dilute HCL.		Limestone
	Carbonate almost completely transformed to dolomite. Often yellowish or pinkish in color. Fizzes weakly with dilute HCL.		Dolomite
Variable	Recrystallized silica		Chert

Micaceous - Appreciable mica, Calcareous - Limey appreciable calcite, Carbonaceous - Appreciable carbon material, Siliceous - Appreciable silica, Argillaceous - Appreciable clay minerals

COMMON IGNEOUS ROCK (Ref. Oregon DOT 1987)			
INTRUSIVE (COARSE GRAINED)	**ESSENTIAL MINERALS**	**COMMON ACCESSORY MINERALS**	**EXTRUSIVE (FINE GRAINED)**
Granite	K-feldspar, Quartz	Plagioclase, mica, amphibole, pyroxene	Rhyolite
Diorite	Plagioclase	Mica, amphibole, pyroxene	Andesite
Gabbro	Plagioclase, Pyroxene	Amphibole	Basalt

BEDDING THICKNESS (Modified after Ref. 1997 FHWA Subsurface Inv. Manual)			
Very thick bedded	Greater than 3' thick (>1m)	Very thin bedded	1/2" to 1 1/4" thick (10mm to 30mm)
Thick bedded	1' to 3' thick (0.3 to 1.0m)	Thickly laminated	1/8" to 1/2" thick (3mm to 10mm)
Medium bedded	4" to 1' thick (0.1 to 0.3m)	Thinly laminated	1/8" or less (paper thin) (<3mm)
Thin bedded	1 1/4" to 4" thick (30mm to 100mm)		

SCALE OF RELATIVE ROCK HARDNESS (Modified after Ref. 1997 FHWA Subsurface Inv. Manual)		
TERM	**FIELD IDENTIFICATION**	**APPROXIMATE UNCONFINED COMPRESSIVE STRENGTH kg/cm² (tsf)**
Extremely Soft	Can be indented by thumb nail.	2.6 - 10
Very Soft	Can be peeled by pocket knife.	10 - 50
Soft	Can be peeled with difficulty by pocket knife. Small, thin pieces can be broken by finger pressure.	50 - 260
Medium Hard	Can be grooved 2mm (0.05") deep by firm pressure of knife.	260 - 520
Moderately Hard	Requires one hammer blow to fracture.	520 - 1040
Hard	Can be scratched with knife or pick only with difficulty. Hard hammer blows required to detach hand specimens.	1040 - 2610
Very Hard	Cannot be scratched by knife or sharp pick. Breaking of specimens requires several hard blows of the pick.	>2610

DEGREE OF WEATHERING (Modified after Ref. AASHTO 1988, DM 7.1 1982, and Oregon DOT 1987)	
Slightly Weathered	Rock generally fresh, joints stained and discoloration extends into rock up to 25mm (1in.),open joints may contain clay, core rings under hammer impact.
Weathered	Rock mass is decomposed 50% or less, significant portions of rock show discoloration and weathering effects, cores cannot be broken by hand or scrape by knife.
Highly Weathered	Rock mass is more than 50% decomposed, complete discoloration of rock fabric, core may be extremely broken and gives clunk sound when struck by hammer, may be shaved with a knife.

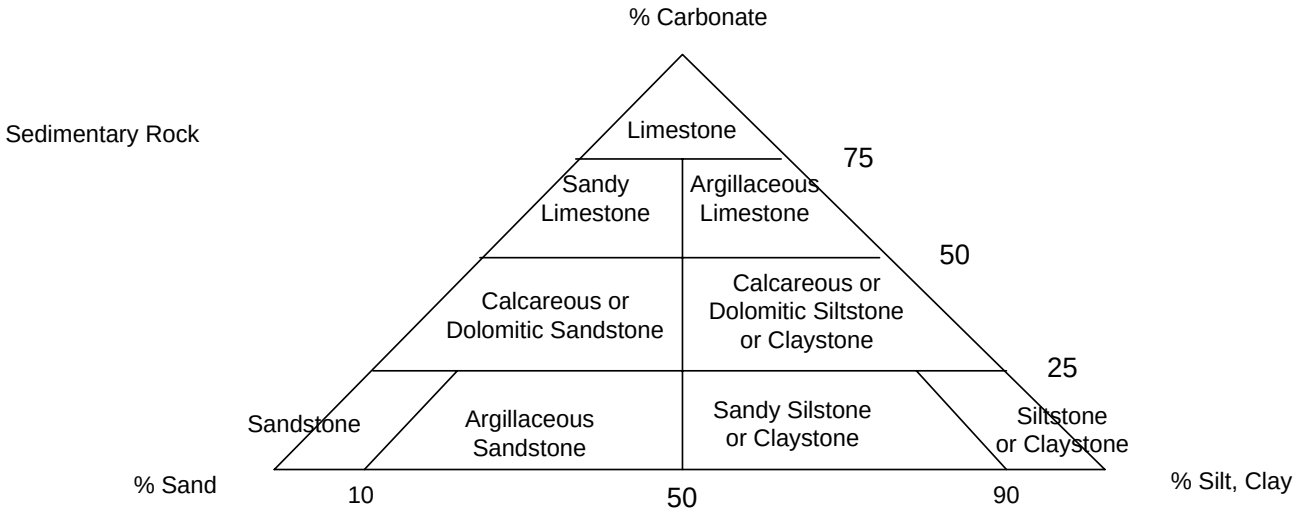
GRAIN SIZE (TYPICALLY FOR SEDIMENTARY ROCKS) -- (Modified after Ref. FHWA 1997 Subsurface Inv. Manual)		
DESCRIPTION	**DIAMETER (mm)**	**FIELD IDENTIFICATION**
Very Coarse Grained	>4.76	
Coarse Grained	2.0 - 4.76	Individual grains can easily be distinguished by eye.
Medium Grained	0.42 - 2.0	Individual grains can be distinguished by eye.
Fine Grained	0.074 - 0.42	Individual grains can be distinguished by eye with difficulty.
Very Fine Grained	<0.074	Individual grains cannot be distinguished by unaided eye.

VOIDS	(Ref. AASHTO 1988)
Pit	Voids barely seen with the naked eye to 6mm (0.25in.)
Vug	Voids 6 to 50mm (0.25 to 2in.) in diameter
Cavity	50 to 600mm (2 to 24in.) in diameter
Cave	>600mm

ROCK QUALITY DESCRIPTION (Ref. AASHTO 1988 AND DM 7.1 1982)	
ROCK MASS DESCRIPTION	**RQD**
Excellent	90 - 100
Good	75 - 90
Fair	50 - 75
Poor	25 - 50
Very Poor	Less than 15

Appendix D.1 Field Identification System for Rock Classification

Field Identification System For Rocks Classification



Shale: Siltone (silty shale) or claystone(clay shale) with prominent bedding cleavage (fissil)

Mudstone: Mixture of silt and clay with blocky or speroidal fracture

American Geological Institute 1982
AGI Data Sheet 20.1